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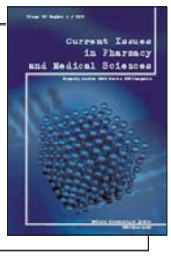

Blood lipids and the risk of myocardial infarction

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ABSTRACT

The most important risk factors for myocardial infarction include among other things, cholesterol (including LDL and HDL) and neutral fats – triglycerides. The aim of the research was the analysis of the levels of biochemical parameters in patients after myocardial infarction and without it on the risk of myocardial infarction. The study was conducted among patients suffering from ischemic heart disease, treated in five randomly selected primary healthcare facilities in Lublin. The study revealed that among patients with high levels of lipids (total cholesterol, LDL cholesterol, and triglycerides) the myocardial infarction is significantly more often observed, although there is a weak but statistically significant correlation between the level of triglycerides and HDL cholesterol concentration. Higher levels of triglycerides are accompanied by lower levels of HDL cholesterol. The variables having a statistically significant impact on the risk of heart attack are elevated levels of total cholesterol and low HDL cholesterol levels. High total cholesterol on average increases the risk of heart attack 3-fold compared to patients whose cholesterol level is normal. Patients with low levels of HDL cholesterol on average have a 2-fold higher risk of myocardial infarction as compared to patients whose concentration is higher than 35 mg%.

Keywords: myocardial infarction, age, lipids, total cholesterol, HDL, LDL, triglycerides

INTRODUCTION

The most important risk factors for myocardial infarction include among other things cholesterol (including LDL and HDL) and neutral fats – triglycerides (TG). Correct concentrations of blood lipids are as follows: total cholesterol less than 200 mg%, LDL cholesterol below 135 mg%, HDL cholesterol above 35 mg%, triglycerides less than 200 mg%. In patients with a higher risk of cardiovascular disease the target values should be smaller. Studies have shown that the risk of coronary arterial disease increases with increasing concentration of serum cholesterol; in patients with high cholesterol, it is 3-fold higher than in the population with normal lipid profile [10].

The aim of this study was to analyze the levels of biochemical parameters in two groups of patients – with a history of myocardial infarction and without myocardial infarction and assessment of the impact of the concentration of these parameters on the risk of myocardial infarction.

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MATERIAL AND METHODS

The study was conducted in patients suffering from ischemic heart disease, treated in five randomly selected primary healthcare facilities in Lublin. Patients reporting to the family doctor for a check received a referral to an analytical laboratory to have basic tests performed. The effect of selected variables – age, total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides (TG) on the risk of myocardial infarction was analyzed. The results were statistically analyzed [9]. The values of the analyzed parameters, measured in nominal scale were characterized by numbers and percentage, but to evaluate the existence of the relationship between the analyzed traits χ^2 test of independence and Spearman rank correlation coefficient and logistic regression analysis, were used. There was a 5% error of inference and the associated significance level $p<0.05$, indicating the existence of significant differences. The analyzed data base and statistical analyzes were performed based on Statistica software 10.0 (StatSoft, Poland).

Characteristics of the subjects

The study included 239 persons aged 31 to 77 years. The average age of the patients was 54.7±10.6 years. Most

frequently, they were patients aged 51 years and half of them did not exceed 53 years of age. The majority of them were men – 185 persons (77.4%) aged 33-77 years. The average age of men was 55.8 ± 9.6 years, and women – 50.9±13.0 years. The youngest participant in the study was 31 years old and the oldest – 69 years old. The observed differences were statistically significant (t=2.99, p<0.05). In the studied group there were 147 patients (61.5%) after myocardial infarction, and 92 people (38.5%) without the history of heart attack.

RESULTS

Table 1 presents the characteristics of analyzed biochemical variables. Total cholesterol for the study population ranged from 121 mg% to 355 mg%, and the average level was 250.1±39.5 mg%.

Table 1. Selected measures of location and dispersion of analyzed biochemical variables.

Lp.	Studied parameters	Average level	Minimum	Maximum	Standard deviation	Coefficient of variation
1.	Total cholesterol	250.1	121.0	355.0	39.5	15.8
2.	HDL	45.0	20.0	94.0	11.7	26.1
3.	LDL	172.8	61.4	257.8	40.4	23.4
4.	TG	161.8	53.0	806.0	94.9	58.7

Average total cholesterol concentration in patients without the history of myocardial infarction was lower and reached 232.7±38.9 mg%, whereas for people with the myocardial infarction it was on the level of 261.1±35.9 mg%. Statistically significant differences in total cholesterol levels among these groups of patients were confirmed (Mann-Whitney test: Z=-5.1; p<0.05) Among the patients in whom myocardial infarction has not occurred total cholesterol concentration was 121 mg% to 298 mg%, and in half of the respondents it was not higher than 235.5 mg% (Me = 238.5). In patients with a history of myocardial infarction the lowest total cholesterol was 192 mg% and the highest – 355 mg%, for half of the patients the concentration was not lower than 255 mg% (Me = 255).

The recommended normal concentration of total cholesterol should be less than 200 mg%, and therefore taking into account the standards, two groups were selected. The first included the respondents in whom the concentration of total cholesterol was lower than 200 mg%; the other group – with the concentration of at least 200 mg% (Table 2). The majority were patients with elevated total cholesterol – 213 persons (89.1%). Statistically significant correlation between cholesterol levels and the incidence of myocardial infarction (χ^2 = 4.54, p<0.05) was confirmed. Elevated cholesterol levels significantly more often were recorded in patients after myocardial infarction.

Table 2. Total cholesterol concentration in patients broken down by groups.

Total cholesterol	Patients without infarct	Patients after infarct	Total
< 200 mg%	15	11	26
	16.3%	7.5%	
≥ 200 mg%	77	136	213
	83.7%	92.5%	
Total	92	147	239

The protective role of HDL cholesterol is reduced to the return transport of cholesterol from tissues to the liver, and also to prevention of the formation of atherosclerotic plaques and stabilization of the existing ones [5]. In the analyzed population HDL cholesterol concentration was 20-94 mg%, and the average level was 45.0±11.7 mg% (Table 1). There were no statistically significant differences in the concentration of HDL cholesterol in patients after myocardial infarction, and individuals in whom myocardial infarction has not occurred (Mann-Whitey test Z = -0.35, p >0.05). Correct HDL cholesterol level is above 35 mg%. Having regard to the above standards, the patients were divided into two groups: patients with the concentration of HDL cholesterol level over 35 mg% and equal to or lower than 35 mg% (Table 3). The majority – 191 persons (79.9%) were patients in whom levels of "good cholesterol" was higher than 35 mg%. There was no statistically significant correlation between the analyzed variables (χ^2 = 3.3, p>0.05) – HDL cholesterol levels, and the fact of myocardial infarction.

Table 3. Total cholesterol concentration in patients broken down by groups.

Patient groups	HDL >35 mg%	HDL ≤ 35 μγ%	Total
Without infarct	79	13	92
After infarct	112	35	147
Total	191	48	239

LDL cholesterol levels among respondents was 61–257.8 mg%, while the average level of LDL cholesterol was 172.8±40.4 mg% (Table 1). The average level of LDL cholesterol was significantly higher among patients with a history of myocardial infarction (p = 6.0, p>0.05) and amounted to 184.4±7.1 mg%, while the average levels of "bad cholesterol" in patients in whom myocardial infarction has not occurred was 154.3±9.7 mg%. LDL cholesterol levels above 150 mg% is associated with an increased risk of coronary artery disease, and therefore the analysis of concentration of "bad" cholesterol in patients was made in two groups (taking into account the above standards). In the majority – 167 persons (69.9%), LDL cholesterol concentration was above normal. Statistically significant relationship between the level of LDL cholesterol and the two groups of patients was confirmed. Statistically elevated levels of "bad cholesterol" were observed in patients after myocardial infarction (χ^2 = 28.1, p>0.05) (Table 4).

Table 4. LDL cholesterol concentration in patients broken down by groups.

Patient groups	LDL >150 mg%	LDL ≤ 150 mg%	Total
Without infarct	46	46	92
After infarct	121	26	147
Total	167	72	239

Triglyceride levels for the study population was very diverse – from 53 mg% to 806 mg%, the average concentration was 161.8±94.9 mg% (Table 1). Statistically significant differences were confirmed in the level of triglycerides in patients after myocardial infarction and those who have not had infarction (Mann-Whitey test Z = 2.2, p>0.05). The range of TG levels in patients not suffering from myocardial infarction varied from 77 mg% to 386 mg%, while in the second group of patients triglyceride levels ranged from 53 mg% to 806 mg%. In most patients – 184 patients (77.0%) TG concentration was below 200 mg% (Table 5). There were no statistically significant differences in the concentration of triglycerides in patients of the analyzed groups ($\chi^2 = 2.33$, p>0.05).

Table 5. The concentration of triglycerides in the study population broken down by groups

Patient groups	TG < mg%	TG ≥ 200 mg%	Total
Without infarct	66	26	92
After Infarct	118	29	147
Total	184	55	239

were included in the first group, the second group included the subjects with more than 200 mg% – discrete feature, independent variable.

- HDL cholesterol levels. Individuals with HDL above 35 mg/dL represented the category I, below that level category II – discrete feature, independent variable
- triglyceride level – the two categories of patients. TG concentration below 200 mg% – category I and above this value – category II of patients. Discrete, independent variable.
- age – age of the patients – a quantitative variable, independent variable.

Estimation of logistic regression equation was performed using a quasi-Newton method. To count loss function the maximum likelihood method was used. The parameters of estimated model are given in Table 6.

Regression coefficients (score) for each variable are statistically significant only for the total cholesterol and HDL cholesterol. This is reflected in the values of statistic test Wald chi^2 – p<0.05 (the variables – total cholesterol and HDL cholesterol - are significant variables explaining the risk of heart attack). The odds ratio indicates that the elevated levels of total cholesterol increase the risk of myocardial infarction on average 3 times (from 1.2 to 6.9 with a 95% likelihood), and low levels of HDL (below 35 mg%), on average over two times (from 1 to 4.6; 95%).

Table 6. The influence of selected factors on the risk of myocardial infarction

N=299	Model: Logistic regression (logit) N of 0's:1's: 147 (data) Dep.var: infarct code Loss: Max likelihood (MS-err. scaled to 1) Total loss: 150.41805723 Chi^2 (5)=17.717 p=.00333					
	Const.BO	Cholesterol cat.	HDL cat.	TG cat.	Age	BMI cat.
Estimate	-2.164127	1.068944	0.8560992	-0.58587	0.02301638	-0.5408703
Standard Error	1.331605	0.4382062	0.3782271	0.3296936	0.01339719	0.3114883
T(233)	-1.625202	2.439363	2.263453	-1.777013	1.718001	-1.736406
p-value	0.1054713	0.0154606	0.02452861	0.07687062	0.08712492	0.08381375
-95%CL	-4.787652	0.205591	0.110917	-1.235432	-0.003378725	-1.154564
+95%CL	0.4593973	1.932297	1.601281	0.06369159	0.04941149	0.07282321
Wald's Chi-square	2.641283	5.95049	5.123218	3.157777	2.951528	3.015107
p-value	0.1041293	0.01471859	0.02361446	0.0755755	0.0858061	0.0825016
Odds ratio (unit ch)	0.1148502	2.912302	2.35396	0.5566214	1.023283	0.5822413
-95% CL	0.008332004	1.228251	1.117302	0.2907093	0.996627	0.315195
+95% CL	1.58312	6.905351	4.959383	1.065764	1.050653	1.07554
Odds ratio (range)		2.912302	2.35396	0.5566214	2.882776	0.5822413
-95% CL		1.228251	1.117302	0.2907093	0.8560544	0.315195
+95% CL		6.905351	4.959383	1.065764	9.70779	1.07554

A weak but statistically significant correlation between the level of TG and HDL cholesterol (test for Spearman's rank correlation coefficient R = -0.31, t = 5.03, p>0.05) was confirmed. Higher levels of triglycerides are accompanied by lower levels of HDL.

Subsequently, the influence of selected variables on the risk of myocardial infarction was analyzed. For this purpose logistic regression was applied. The influence of variables like age, total cholesterol, HDL and triglyceride levels on the risk of myocardial infarction were analyzed. Variables:

- total cholesterol – two categories of patients were separated. Patients with cholesterol below 200 mg%

Summary of correct and incorrect classification (predicted versus observed values) is presented in Table 7. The odds ratio calculated as the ratio of the product of the correctly classified cases to the product of incorrectly classified is OR = 1.8, which indicates that the model classifies the cases better than would be expected by pure chance.

Table 7. Correct and incorrect classification of cases with the forecasting model used.

Observed	Classification of cases (stat. data) Odds ratio: 1.7639 per cent correct: 61.51%		
	Pred. 0.000000	Pred. 1.000000	Percent correct
0.000000	20	72	21.73913
1.000000	20	127	86.39455

DISCUSSION

Cardiovascular diseases are a major cause of mortality in Poland. The most common risk factor for these diseases in the Polish population are lipid disorders, reported in more than 60% of Polish adults (about 18 million, the study NATPOL PLUS) [11].

Increased serum concentrations of total cholesterol and LDL cholesterol levels are among the main risk factors for cardiovascular diseases, including myocardial infarction. Hypertriglyceridemia and low HDL cholesterol concentration are independent risk factors for coronary heart disease [2]. The reduction in total cholesterol in the plasma by 10% will reduce the incidence of coronary artery disease by 25% in 5 years [3].

Clear evidence was obtained that the reduction in LDL cholesterol reduces the risk of cardiovascular diseases and is important in the prevention of coronary artery disease [6]. Any reduction in LDL cholesterol of 1.0 mmol/L (40 mg%) is associated with decreased mortality from for cardiovascular diseases and the incidence of non-fatal heart attacks by 20-25% [1].

It is known that low HDL cholesterol exhibits independent relationship with a higher risk of coronary artery disease [8]. The ERFC study demonstrated that the greater the concentration of HDL cholesterol, the lower was the risk of coronary artery disease, and an increase in the concentration of non-HDL cholesterol, increased the risk of coronary heart disease [8]. Protective effect of HDL cholesterol was observed regardless of the concentration of triglycerides.

Numerous studies confirm the impact of dyslipidemia on the risk of myocardial infarction. The prospective study, Hart Copenhagen City Study, which included 6400 men and 7600 women over 26-31 years old, demonstrated an increased risk of heart attack in people with elevated triglyceride levels [4]. Currently, it is still believed that fasting TG concentration 1.7 mmol/L (about 150 mg/dl) is an indicator of increased risk.

The TNT study has shown that in spite of achieving low levels of LDL cholesterol (F mg/dl), with low concentration of HDL cholesterol (≤37 mg/dl), the risk of cardiovascular events during 5-year observation was by 39% higher compared with the patients with high HDL values (≥55 mg/dl) [7].

Priority task in the prevention of myocardial infarction should therefore be to reduce hypercholesterolemia in the general population, especially in those at risk. Measures should include intensive counseling on changes in diet and lifestyle, and among those with a higher risk of cardiovascular diseases, it is essential to include pharmacotherapy.

CONCLUSIONS

1. Among people with elevated lipids (total cholesterol, LDL cholesterol, and trigicerides) the presence of infarctions is found significantly more often.
2. There is a weak but statistically significant correlation between the level of triglycerides and HDL cholesterol. Higher levels of triglycerides are accompanied by lower levels of HDL cholesterol.
3. The variables having a statistically significant impact on the risk of heart attack are elevated levels of total cholesterol and low HDL cholesterol levels.
4. High total cholesterol increases on average 3-fold the risk of heart attack compared to patients whose cholesterol level is normal.
5. Patients with low levels of HDL cholesterol, on average have a 2-fold higher risk of myocardial infarction as compared to patients whose concentration is higher than 35 mg%.

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